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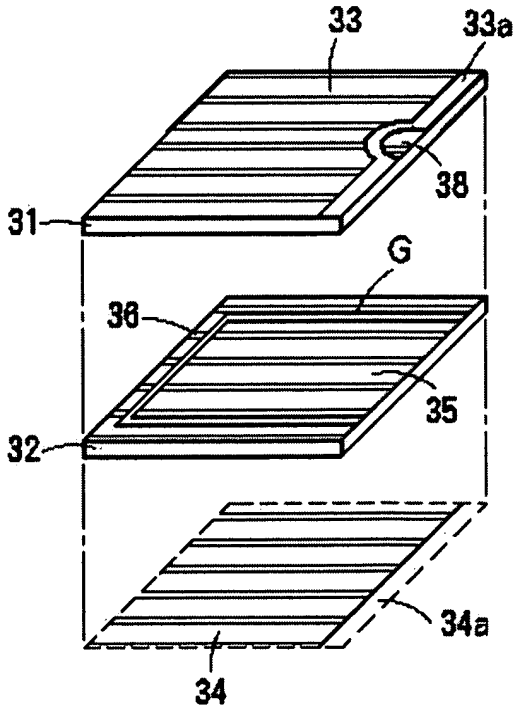
(54) PIEZOELECTRIC ACOUSTIC CONVERTER AND ITS MANUFACTURING METHOD

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a piezoelectric acoustic converter in which failure rate can be improved by preventing short circuit of inner and outer electrodes due to migration and protecting a ceramic layer against cracking at the time of polarization.
SOLUTION: A plurality of piezoelectric ceramic layers 31 and 32 are laid in layer to form a multilayer body, and all ceramic layers 31 and 32 are polarized in the same direction in the thickness direction. An AC signal is applied between outer electrodes 33 and 34 provided on the surface and rear of the multilayer body and an inner electrode 35 provided between the ceramic layers, thus causing bending vibration of the multilayer body. A dummy electrode 36 is provided between the piezoelectric ceramic layers 31 and 32 on the outside of the inner electrode 35 through a gap G, wherein a part of the inner electrode 35 is exposed to at least one end face of the piezoelectric ceramic layer and the dummy electrode 36 is exposed to the other end face of the piezoelectric ceramic layer. The outer electrodes 33 and 34 extend to an end face of the piezoelectric ceramic layer other than that where the inner electrode 35 is exposed.



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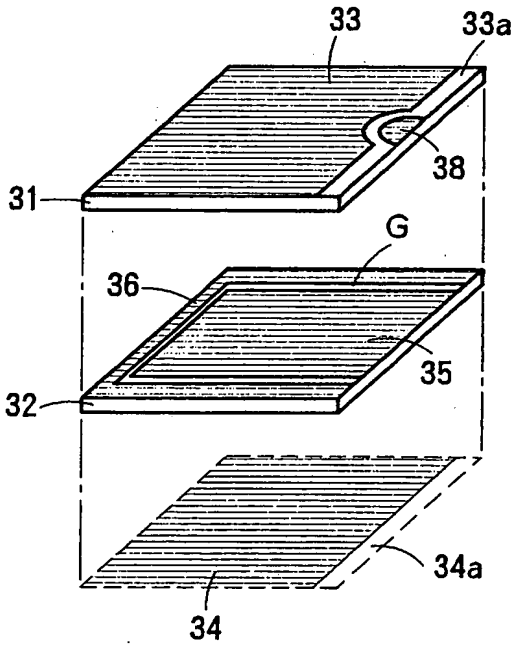
(54)【発明の名称】　圧電型電気音響変換器およびその製造方法

(57)【要約】
【課題】マイグレーションによる内部電極と外部電極との短絡を防止するとともに、分極時のセラミック層の割れを防止し、良品率を改善できる圧電型電気音響変換器を提供する。
【解決手段】複数の圧電セラミック層３１，３２を積層して積層体を構成し、すべてのセラミック層３１，３２を厚み方向において同一方向に分極するとともに、積層体の表裏主面に設けられた外部電極３３，３４と各セラミック層の間に設けられた内部電極３５との間に交番信号を印加することにより、上記積層体を屈曲振動させる圧電型電気音響変換器である。圧電セラミック層３１，３２の間に、内部電極３５の外側にギャップＧを介して隔てられたダミー電極３６が設けられ、内部電極３５の一部は圧電セラミック層の少なくとも１つの端面に露出しており、ダミー電極３６は圧電セラミック層の他の端面に露出している。外部電極３３，３４は、内部電極３５が露出している圧電セラミック層の端面以外の端面まで延びている。



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【特許請求の範囲】

【請求項１】複数の圧電セラミック層を積層して積層体を構成し、すべてのセラミック層を厚み方向において同一方向に分極するとともに、積層体の表裏主面に設けられた外部電極と各セラミック層の間に設けられた内部電極との間に交番信号を印加することにより、上記積層体を屈曲振動させる圧電型電気音響変換器において、上記圧電セラミック層の間に、上記内部電極の外側にギャップを介して隔てられたダミー電極が設けられ、上記内部電極の一部は圧電セラミック層の少なくとも１つの端面に露出しており、上記ダミー電極は圧電セラミック層の他の端面に露出しており、上記外部電極は、内部電極が露出している圧電セラミック層の端面以外の端面まで延びていることを特徴とする圧電型電気音響変換器。

【請求項２】上記内部電極とダミー電極とのギャップ幅は、０．０５～０．４０mmであることを特徴とする請求項１に記載の圧電型電気音響変換器。

【請求項３】上記内部電極は、圧電セラミック層の１つの端面に露出するように方形に形成され、上記ダミー電極は内部電極の３辺をギャップを介して取り囲むようにコ字形に形成され、上記内部電極が露出する圧電セラミック層の端面と対応する外部電極の部位に縁取り部が設けられていることを特徴とする請求項１または２に記載の圧電型電気音響変換器。

【請求項４】上記外部電極の縁取り部が設けられた部位に、セラミック層の端面に設けられた端面電極を介して内部電極と接続された引出電極が形成されていることを特徴とする請求項３に記載の圧電型電気音響変換器。

【請求項５】上記引出電極は圧電セラミック層の２つの角部に、かつ異なる二辺に跨がって形成されており、上記引出電極はダミー電極と厚み方向から見て重ならない位置に設けられており、上記ダミー電極の両端部と内部電極との間に、圧電セラミック層の端面に沿って島状の補助電極が形成されていることを特徴とする請求項４に記載の圧電型電気音響変換器。

【請求項６】圧電セラミックよりなる複数のグリーンシートを準備する工程と、少なくとも１つのグリーンシートの表面に内部電極およびダミー電極となる電極パターンを形成する工程と、複数のグリーンシートを上記内部電極およびダミー電極を間に積層して積層体を得る工程と、積層体を焼成して圧電体を得る工程と、圧電体の表面に表側の外部電極となる電極パターンを形成する工程と、圧電体の裏面に裏側の外部電極となる電極パターンを形成する工程と、表裏の外部電極間に電圧を印加して圧電体の厚み方向に一様に分極を行なう工程と、圧電体を１素子の寸法にカットする工程と、カットされた素子の端面に表裏の外部電極を導通させる端面電極と、内部電極を素子の表面または裏面の少なくとも一方に引き出すための端面電極とを形成する工程とを有し、上記圧電体を素子にカットした状態において、圧電セラミック層

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の間には内部電極とその外側にギャップを介して隔てられたダミー電極とが設けられ、内部電極の一部は圧電セラミック層の少なくとも１つの端面に露出しており、ダミー電極は圧電セラミック層の他の端面に露出しており、上記表裏の外部電極は、内部電極が露出している圧電セラミック層の端面以外の端面まで延びていることを特徴とする圧電型電気音響変換器の製造方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は圧電受話器、圧電サウンダ、圧電スピーカ、圧電ブザーなどの圧電型電気音響変換器およびその製造方法に関するものである。

【０００２】

【従来の技術】従来、電子機器、家電製品、携帯電話機などにおいて、警報音や動作音を発生する圧電ブザーあるいは圧電受話器として圧電型電気音響変換器が広く用いられている。この種の圧電型電気音響変換器は、金属板の片面に圧電素子を貼り付けてユニモルフ型振動板を構成し、金属板の周縁部をケースの中に支持するとともに、ケースの開口部をカバーで閉鎖した構造のものである。しかしながら、ユニモルフ型振動板の場合、電圧印加によって外径が伸縮するセラミック板を、寸法変化しない金属板に接着して屈曲振動させるものであるから、その変位量つまり音圧が小さいという欠点がある。

【０００３】そこで、複数の圧電セラミック層からなる積層構造のバイモルフ型振動板が提案されている（特開２００１－９５０９４号公報）。この振動板は、２層または３層の圧電セラミック層を積層して積層体を得るとともに、この積層体の表裏面に外部電極を形成し、各セラミック層の間に内部電極を設けたものである。全てのセラミック層は厚み方向に同一方向に分極されており、外部電極と内部電極との間に交番信号を印加することにより、積層体を屈曲振動させる。このような積層構造の振動板では、ユニモルフ型振動板に比べて変位量が大きく、音圧が増大する利点がある。

【０００４】

【発明が解決しようとする課題】上記のような積層構造の振動板を製造する場合、各セラミック層が薄肉であるため、積層体の端面に露出する内部電極と外部電極とがマイグレーションによって短絡しやすいという問題がある。マイグレーション対策として、図１に示すように、セラミック層１の少なくとも１辺に表裏の外部電極２，３を露呈させるとともに、他の辺には外部電極２，３を切除した縁取り部２ａ，３ａを形成し、外部電極２，３が露呈した辺に内部電極４の縁取り部４ａを形成し、残りの辺に内部電極４を露呈させた電極形状とする方法が考えられる。なお、図１において、裏側の外部電極３は投影図として描かれている。このような電極形状とすることで、セラミック層１の端面において外部電極２，３と内部電極４とが厚み方向に接近せず、マイグレーショ

ンを解消できる。なお、図１では外部電極２，３の３辺に縁取り部２ａ，３ａを形成し、内部電極４の１辺に縁取り部４ａを形成したが、これとは逆に内部電極４の３辺に縁取り部を形成し、外部電極２，３の１辺に縁取り部を形成しても同様の効果を有する。

【０００５】ところが、上記のような電極形状を持つ積層体に対し、表裏の外部電極２，３間に直流電圧を印加して分極を行なうと、内部電極４と縁取り部４ａとの間でセラミック層１の伸びに差が生じ、内部電極４と縁取り部４ａとの境界のセラミック層１に割れが発生し、良品率を低下させるという問題がある。すなわち、内部電極４が端面に露呈している辺では電極４によってセラミック層１の伸びが抑制されるのに対し、縁取り部４ａが設けられた辺ではセラミック層１の伸びが大きくなり、その伸びの差によってセラミック層１に割れが発生するからである。

【０００６】そこで、本発明の目的は、マイグレーションによる内部電極と外部電極との短絡を防止するとともに、分極時のセラミック層の割れを防止し、良品率を改善できる圧電型電気音響変換器を提供することにある。

【０００７】

【課題を解決するための手段】上記目的を達成するため、請求項１に係る発明は、複数の圧電セラミック層を積層して積層体を構成し、すべてのセラミック層を厚み方向において同一方向に分極するとともに、積層体の表裏主面に設けられた外部電極と各セラミック層の間に設けられた内部電極との間に交番信号を印加することにより、上記積層体を屈曲振動させる圧電型電気音響変換器において、上記圧電セラミック層の間に、上記内部電極の外側にギャップを介して隔てられたダミー電極が設けられ、上記内部電極の一部は圧電セラミック層の少なくとも１つの端面に露出しており、上記ダミー電極は圧電セラミック層の他の端面に露出しており、上記外部電極は、内部電極が露出している圧電セラミック層の端面以外の端面まで延びていることを特徴とする圧電型電気音響変換器を提供する。

【０００８】また、請求項６に係る発明は、圧電セラミックよりなる複数のグリーンシートを準備する工程と、少なくとも１つのグリーンシートの表面に内部電極およびダミー電極となる電極パターンを形成する工程と、複数のグリーンシートを上記内部電極およびダミー電極を間に積層して積層体を得る工程と、積層体を焼成して圧電体を得る工程と、圧電体の表面に表側の外部電極となる電極パターンを形成する工程と、圧電体の裏面に裏側の外部電極となる電極パターンを形成する工程と、表裏の外部電極間に電圧を印加して圧電体の厚み方向に一様に分極を行なう工程と、圧電体を１素子の寸法にカットする工程と、カットされた素子の端面に表裏の外部電極を導通させる端面電極と、内部電極を素子の表面または裏面の少なくとも一方に引き出すための端面電極とを形成する工程とを有し、上記圧電体を素子にカットした状態において、圧電セラミック層の間には内部電極とその外側にギャップを介して隔てられたダミー電極とが設けられ、内部電極の一部は圧電セラミック層の少なくとも１つの端面に露出しており、ダミー電極は圧電セラミック層の他の端面に露出しており、上記表裏の外部電極は、内部電極が露出している圧電セラミック層の端面以外の端面まで延びていることを特徴とする圧電型電気音響変換器の製造方法である。

【０００９】セラミック層の間に、内部電極とダミー電極とが設けられるが、両電極はギャップを介して隔てられているので、電気的に導通していない。内部電極の一部はセラミック層の少なくとも１つの端面に露出しており、ダミー電極はセラミック層の他の端面に露出している。そして、外部電極は、内部電極が露出しているセラミック層の端面以外の端面まで延びている。換言すると、外部電極は内部電極が露出した端面まで延びていない。そのため、セラミック層の端面において、内部電極と外部電極とが厚み方向に接近せず、マイグレーションによる短絡を防止できる。また、ダミー電極と外部電極とは厚み方向に接近し、短絡する可能性はあるが、ダミー電極と内部電極とは電気的に絶縁されているので、外部電極と内部電極とが短絡する心配がない。また、分極時に内部電極の存在する部分と存在しない部分とでセラミック層に伸びの差が生じても、内部電極の存在しない部分にはダミー電極が設けられているので、セラミック層の伸びの差が小さくなり、セラミック層の割れを抑制できる。

【００１０】内部電極は、セラミック層の１辺の全長に亘って露出している必要はなく、１辺の一部のみに露出していてもよいし、２辺または３辺に亘って露出していてもよい。同様に、外部電極の露出もセラミック層の辺の全長にわたって露出している必要はなく、部分的に露出したものでもよい。セラミック層は２層に限らず、３層であってもよい。３層の場合、中央のセラミック層の両面に内部電極が設けられるので、電位が等しく、屈曲振動に寄与しない。

【００１１】請求項２のように、内部電極とダミー電極とのギャップ幅を、０．０５～０．４０mmとするのが望ましい。ギャップ幅を広くすると、分極時のセラミック層の伸びの差が大きくなり、割れの原因になる。一方、ギャップ幅を狭くし過ぎると、内部電極とダミー電極との絶縁距離が保てなくなる。そこで、ギャップ幅を０．０５～０．４０mmとすれば、割れの防止と絶縁距離の確保とを両立できる。

【００１２】請求項３のように、内部電極を、圧電セラミック層の１つの端面に露出するように方形に形成し、ダミー電極を内部電極の３辺をギャップを介して取り囲むようにコ字形に形成し、内部電極が露出する圧電セラミック層の端面と対応する外部電極の部位に縁取り部を

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設けてもよい。この場合には、内部電極および外部電極の電極形状が単純化され、製造が簡単になる。また、内部電極が１辺にしか露出しないので、マイグレーションが起こりにくく、安定した特性の振動板が得られる。

【００１３】請求項４のように、請求項３における外部電極の縁取り部が設けられた部位に、端面電極を介して内部電極と接続された引出電極を形成してもよい。すなわち、振動板の外部電極は外部に露出しているので、外部との電気的接続は容易であるが、内部電極はセラミック層の間に設けられているので、そのままでは外部と接続できない。そこで、内部電極を振動板の少なくとも表面に引き出すため、外部電極の縁取り部が設けられた部位に引出電極を設け、この引出電極と内部電極とをセラミック層の端面に設けられた端面電極を介して接続する。これによって、内部電極を外部と容易に接続できる。

【００１４】請求項５のように、引出電極を圧電セラミック層の２つの角部に、かつ異なる二辺に跨がって形成し、引出電極をダミー電極と厚み方向から見て重ならない位置に設け、ダミー電極の両端部と内部電極との間に、圧電セラミック層の端面に沿って島状の補助電極を形成してもよい。このように構成すれば、分極時の割れを防止できるとともに、大きなマザー基板から積層体を多数個取りする場合、カット位置と電極形成位置とのばらつきに対応しやすい。また、引出電極の幅を比較的広くすることができるので、有効である。

【００１５】請求項６の製造方法では、請求項１における振動板を効率よく製造できる。分極用電極を形成した後で、これをエッチングし、外部電極とする方法では、製造過程で積層圧電体よりなる振動板が割れやすい。特に、厚みが５０μｍ以下の薄肉な振動板では、エッチング処理においてハンドリング等による割れ、欠け不良率が大幅に悪化する。これに対し、請求項６では分極用電極をそのまま外部電極として使用するので、エッチングが不要となり、振動板に負荷がかからず、割れ，欠け不良率を改善できる。

【００１６】

【発明の実施の形態】図２～図９は本発明の第１の実施形態である表面実装型の圧電型電気音響変換器を示す。この電気音響変換器は、大略、ケース１０と蓋板２０と積層構造の振動板３０とで構成されている。

【００１７】ケース１０はセラミックスまたは樹脂などの絶縁性材料で底壁部１０ａと４つの側壁部１０ｂ～１０ｅとを持つ４角形の箱型に形成されている。ケース１０を樹脂で構成する場合には、ＬＣＰ（液晶ポリマー），ＳＰＳ（シンジオタクチックポリスチレン），ＰＰＳ（ポリフェニレンサルファイド），エポキシなどの耐熱樹脂が望ましい。対向する２つの側壁部１０ｂ，１０ｄの内側には段差状の支持部１０ｆ，１０ｇが設けられ、その上に一対の端子１１，１２の内部接続部１１

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ａ，１２ａが露出している。端子１１，１２はケース１０にインサート成形されたものであり、ケース１０の外部に突出した外部接続部１１ｂ，１２ｂが側壁部１０ｂ，１０ｄの外面に沿ってケース１０の底面側へ折り曲げられている。ケース１０の他の１つの側壁部１０ｃと底壁部１０ａとの境界には、第１の放音孔１０ｈが形成されている。ケース１０の上面開口部には、ケース１０と同様な材料よりなる蓋板２０が接着剤（図示せず）によって接着される。蓋板２０には第２の放音孔２１が形成されている。

【００１８】振動板３０は、図５～図９に示すように、２層の圧電セラミックス層３１，３２を積層し、その表裏面を樹脂層４０，４１で覆ったものである。これら樹脂層４０，４１は、セラミック層３１，３２の落下衝撃などによる割れを防止するための保護膜である。ここでは、セラミックス層３１，３２として１０ｍｍ×１０ｍｍ×２０μｍのＰＺＴ系セラミックスを使用し、樹脂層４０，４１として厚みが５～１０μｍのポリアミドイミド系樹脂を使用した。

【００１９】積層されたセラミック層３１，３２の表裏主面には外部電極３３，３４が形成され、セラミックス層３１，３２の間には内部電極３５とダミー電極３６とが形成されている。２つのセラミックス層３１，３２は、図５，図６に太線矢印で示すように厚み方向において同一方向に分極されている。表側の外部電極３３と裏側の外部電極３４の１辺には縁取り部（または空白部）３３ａ，３４ａが形成され、他の辺はセラミック層３１，３２の縁部まで伸びている。そして、縁部まで伸びている外部電極３３，３４は振動板３０の一方の端面に形成された端面電極３７（図６参照）に接続されている。そのため、表裏の外部電極３３，３４は相互に接続されている。表側の外部電極３３の縁取り部３３ａが設けられたセラミック層３１の表面には、外部電極３３と導通しない引出電極３８が形成されている。内部電極３５は、外部電極３３，３４の縁取り部３３ａ，３４ａが形成されたセラミック層３１，３２の端面にのみ露出するように方形に形成され、ダミー電極３６は内部電極３５の３辺をギャップＧを介して取り囲むようにコ字形に形成されている。このギャップＧの幅は、０．０５～０．４０ｍｍが望ましく、ここでは０．１５ｍｍに設定した。ダミー電極３６はセラミック層３１，３２の３辺の端面に露出している。端面電極３７が形成された端面と対向する振動板３０の端面には、内部電極３５と引出電極３８とを接続する端面電極３９が形成されている。なお、端面電極３７を設けることで、外部電極３３，３４が相互に接続されると同時に、ダミー電極３６とも接続される。しかし、ダミー電極３６は内部電極３５と電気的に絶縁されているので、電気的特性に支障はない。

【００２０】表側の樹脂層４０には、振動板３０の対向する２辺に、外部電極３３が露出する切欠部４０ａと、

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引出電極３８が露出する切欠部４０ｂとが形成されている。なお、この例では表面にのみ切欠部４０ａ，４０ｂを設けたが、表裏両面に設けてもよい。表裏両面に切欠部４０ａ，４０ｂを設ける場合には、裏面の切欠部４０ａに外部電極３４を露出させ、裏面の切欠部４０ｂに引出電極３８を露出させればよい。

【００２１】上記振動板３０はケース１０に収納され、対向する２辺が支持部１０ｆ，１０ｇの上に載置される。そして、樹脂層４０の切欠部４０ａから露出する外部電極３３と端子１１の内部接続部１１ａとが導電性接着剤２２によって接続され、同じく切欠部４０ｂから露出する引出電極３８と端子１２の内部接続部１２ａとが導電性接着剤２３によって接続される。導電性接着剤２２，２３を硬化させた後、振動板３０の周囲とケース１０との隙間にシリコーン系接着剤などの弾性封止剤２４を環状に塗布し硬化させることで、振動板３０の表側と裏側との間の空気漏れが防止される。なお、導電性接着剤２２，２３を塗布，硬化させた後、弾性封止剤２４を塗布，硬化させる方法に限らず、先に弾性封止剤２４を塗布，硬化させた後で導電性接着剤２２，２３を塗布，硬化させてもよい。また、導電性接着剤２２，２３は、予め振動板３０の両端部に塗布した状態で、ケース１０に収容してもよい。

【００２２】この実施形態の電気音響変換器では、端子１１，１２間に所定の交番電圧を印加することで、外部電極３３，３４と内部電極３５との間に交番電圧が印加され、振動板３０を屈曲振動させることができる。分極方向と電界方向とが同一方向である圧電セラミックス層は平面方向に縮み、分極方向と電界方向とが逆方向である圧電セラミックス層は平面方向に伸びるので、全体として厚み方向に屈曲する。振動板３０が金属板を有しない圧電セラミックスの積層構造体であり、厚み方向に順に配置された２つの振動領域が相互に逆方向に振動するので、ユニモルフ型振動板に比べて大きな変位量、つまり大きな音圧を得ることができる。振動板３０によって発生した音は、蓋板２０に設けられた第２の放音孔２１より外部へ放出される。また、２層の圧電セラミック層３１，３２の端面において、外部電極３３，３４と内部電極３５とが近接しないので、マイグレーションによる外部電極３３，３４と内部電極３５との短絡を防止できる。

【００２３】図１０は振動板３０の製造工程を示す。（ａ）のように、電極を形成していない第１のセラミックグリーンシート３１Ａと、表面に内部電極３５およびダミー電極３６を形成した第２のセラミックグリーンシート３２Ａとを準備する。セラミックグリーンシートとしては、例えばＰＺＴ系セラミックスを用いた。また、内部電極３５およびダミー電極３６として、銀，パラジウム，有機バインダなどを含む導電ペーストを印刷法により塗布した。次に、（ｂ）のように、グリーンシート

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３１Ａ，３２Ａを積層し、約１１００℃で焼成して厚さ約４０μｍの圧電体３０Ａを得る。次に、（ｃ）のように、マザー基板状態の圧電体３０Ａの表面に表側の外部電極３３Ａを形成するとともに、圧電体３０Ａの裏面に裏側の外部電極３４Ａを形成する。形成方法としては、例えばメタルマスクを用いたスパッタリングなどの薄膜形成法を用いた。このとき、表側の外部電極３３Ａには、縁取り部となる空白部３３ａと引出電極３８となる島状電極とを形成しておく。また、裏側の外部電極３４Ａには、縁取り部となる空白部３４ａを形成しておく。外部電極３３Ａ，３４Ａの形成後、圧電体３０Ａの表裏の外部電極３３Ａ，３４Ａ間に電圧を印加して分極を行なう。分極条件は、電界：３．０ｋＶ／ｍｍ、保持時間×保持温度＝３０ｓｅｃ×５０℃で一定とした。この時、セラミック層の間に設けられた電極３５，３６には、殆ど空白部が存在しないので、セラミック層の伸びの差が殆どなく、セラミック層の割れを防止できる。分極後、圧電体３０Ａの表裏面に樹脂コーティングを施し、（ｃ）の破線ＣＬでカットして（ｄ）のような素子を得る。このとき、カットラインＣＬが縁取り部３３ａ，３４ａの中心を通るようにカットする。カットされた素子の表裏面に樹脂層４０，４１を形成するとともに、端面電極３７，３９を形成することにより、振動板３０が得られる。

【００２４】図１に示すような外部電極形状の場合、外部電極２の周囲に縁取り部２ａを設ける必要上、まず電極を全面に形成した後、縁取り部に相当する箇所にレジストインクを塗布し、エッチングを行なって縁取り部２ａを形成するという工程が必要になる。これに対し、上記のように外部電極３３Ａ，３４Ａが３辺まで伸びている場合には、電極形状を単純化できることから、エッチングなどの煩雑な処理が不要となり、低負荷のパターンニング法を選択することが可能となる。そのため、工程の簡略化とハンドリングによる割れ、欠け不良を改善でき、薄肉な圧電体３０Ａであっても、良品率が向上し、量産化できる。

【００２５】図１１は振動板における外部電極と内部電極の他の実施例を示す。（ａ）では、内部電極３５およびダミー電極３６の形状は第１実施例と同等であるが、外部電極３３の一辺に空白部３３ｂを介して帯状の引出電極３８を設けた点で第１実施例と異なる。この引出電極３８は端面電極を介して内部電極３５と接続される。（ｂ）では、内部電極３５の隣合う２辺がセラミック層の端面に露出しており、残りの２辺にギャップＧを介してダミー電極３６が形成されている。同様に、外部電極３３の２辺、特に内部電極３５が露出する２辺と対応する部分に縁取り部３３ａが形成され、他の２辺はセラミック層の周縁まで伸びている。（ｃ）は、内部電極３５の３辺がセラミック層の端面に露出しており、残りの１辺にギャップＧを介してダミー電極３６が形成されてい

る。また、外部電極３３の３辺、つまり内部電極３５が露出する３辺と対応する部分に縁取り部３３ａが形成され、残りの１辺はセラミック層の周縁部まで伸びている。（ｄ）は、内部電極３５の対向する２辺がセラミック層の端面に露出しており、残りの２辺にギャップＧを介してダミー電極３６が形成されている。外部電極３３の２辺、特に内部電極３５が露出する２辺と対応する部分に縁取り部３３ａが形成され、他の２辺はセラミック層の周縁まで伸びている。（ａ）～（ｄ）のいずれの電極形状も、マイグレーションを防止できるとともに、分極時の割れを防止できる。なお、裏側の外部電極３４は表側の外部電極３３と同様の形状とすればよい。

【００２６】図１２は振動板における外部電極と内部電極のさらに他の実施例を示す。（ａ）では、内部電極３５がセラミック層の１辺の中の一部にのみ露出しており、その他の部分をギャップＧを介してダミー電極３６が取り囲んでいる。一方、外部電極３３の内部電極３５が露出した辺に縁取り部３３ａが形成され、この縁取り部３３ａの中で内部電極３５が露出した部分と対応する箇所に、島状の引出電極３８が形成されている。この引出電極３８も端面電極を介して内部電極３５と接続される。（ｂ）では、内部電極３５がセラミック層の１辺およびその辺と隣接する２辺の一部まで露出しており、その他の部分をギャップＧを介してダミー電極３６が取り囲んでいる。一方、外部電極３３の内部電極３５が露出した辺に縁取り部３３ａが形成され、さらに縁取り部３３ａの両端部近傍で内部電極３５が露出した部分と対応する箇所に、島状の引出電極３８が形成されている。この引出電極３８は端面電極を介して内部電極３５と接続される。この電極パターンの場合、外部電極３３は勿論、内部電極３５もマザー基板の段階で互いに繋がった状態にあるので、内部電極３５の形成が簡単になる利点がある。（ｃ）は、（ｂ）の電極形状を修正したものであり、内部電極３５がセラミック層の１辺およびその辺と隣接する２辺の一部まで露出しており、その他の部分をギャップＧを介してダミー電極３６が取り囲んでいる。ダミー電極３６と内部電極３５との間に、セラミック層の端面に沿って２個の島状の補助電極４２が形成されている。外部電極３３の内部電極３５が露出した辺に縁取り部３３ａが形成され、縁取り部３３ａの両端部には内部電極３５および補助電極４２と対応する島状の引出電極３８が形成されている。この実施例では、引出電極３８をセラミック層の角部に配置することで、引出電極３８の形成が容易になり、量産性が向上する。もし、内部電極３５およびダミー電極３６を（ｂ）のような形状とすると、ダミー電極３６と引出電極３８とが厚み方向に重なり、マイグレーションによって短絡する恐れが生じる。そこで、ダミー電極３６と内部電極３５との間に補助電極４２を形成することで、ダミー電極３６と引出電極３８との短絡を防止している。また、この実施例では、マザー基板から振動板を多数個取りする場合、カット位置と電極形成位置とのばらつきに対応しやすく、引出電極３８の幅を広く取れるので有効である。（ｄ）は、内部電極３５，ダミー電極３６および補助電極４２を図１２の（ｃ）と同様とし、外部電極３３を図１１の（ａ）と同様にしたものである。すなわち、外部電極３３の一辺に空白部３３ｂを介して帯状の引出電極３８を設けてある。この場合も、補助電極４２によって、引出電極３８とダミー電極３６とが短絡するのを防止できる。

【００２７】本発明は上記実施形態に限定されるものではなく、本発明の趣旨を逸脱しない範囲で変更可能である。例えば、振動板３０は２層の圧電セラミックス層を積層したものであるが、３層以上の圧電セラミックス層を積層したものでもよい。また、振動板３０は四角形のほか、円形であってもよい。

【００２８】本発明のケースは、図２～図４に示されるような端子を持つケースと、その上面に接着される蓋板とで構成されたものに限らない。例えば、前述の特開２００１－９５０９４号公報の図７，図８に示されるように、振動板を支持固定できる支持部を持つキャップと、外部接続用の電極を持つ基板とでケースを構成してもよい。ケースに固定される端子としては、上記実施形態のようなインサート端子に限るものではなく、例えばケースの支持部上面から外部に至る薄膜あるいは厚膜の電極であってもよい。

【００２９】

【発明の効果】以上の説明で明らかなように、請求項１に係る発明によれば、セラミック層の間に内部電極とその外側にギャップを介して隔てられたダミー電極とを設け、内部電極の一部をセラミック層の少なくとも１つの端面に露出させるとともに、ダミー電極をセラミック層の他の端面に露出させ、表裏の外部電極を内部電極が露出している圧電セラミック層の端面以外の端面まで延ばしたので、セラミック層の端面において内部電極と外部電極とが厚み方向に接近せず、マイグレーションによる短絡を防止できる。また、分極時に内部電極の存在する部分と存在しない部分とでセラミック層に伸びの差が生じても、内部電極の存在しない部分にはダミー電極が設けられているので、セラミック層の伸びの差が小さくなり、セラミック層の割れを抑制できるという作用効果を有する。

【００３０】請求項６にかかる発明によれば、分極用電極をそのまま外部電極として使用するので、エッチングが不要となり、振動板に負荷がかからず、割れ，欠け不良率を改善できる。そのため、積層圧電体よりなる振動板を効率よく製造できる。

【図面の簡単な説明】

【図１】本発明の前提となる圧電振動板の分解斜視図である。

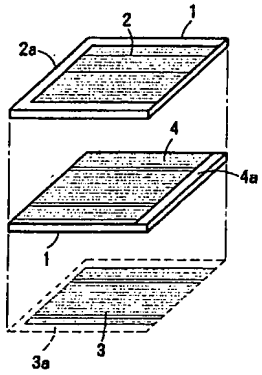
11　　12

【図２】本発明に係る圧電型電気音響変換器の第１実施形態の分解斜視図である。
【図３】図２のＡ－Ａ線断面図である。
【図４】図２のＢ－Ｂ線断面図である。
【図５】図２の圧電型電気音響変換器に用いられる圧電振動板の斜視図である。
【図６】図５のＣ－Ｃ線断面図である。
【図７】図５に示す圧電振動板の樹脂層を取り除いた状態の斜視図である。
【図８】図７に示す圧電振動板の分解斜視図である。
【図９】図７に示す圧電振動板の内部電極および外部電極図である。
【図１０】図７に示す圧電振動板の製造方法を示す工程図である。
【図１１】圧電振動板の内部電極および外部電極の他のパターン図である。
【図１２】圧電振動板の内部電極および外部電極のさらに他のパターン図である。

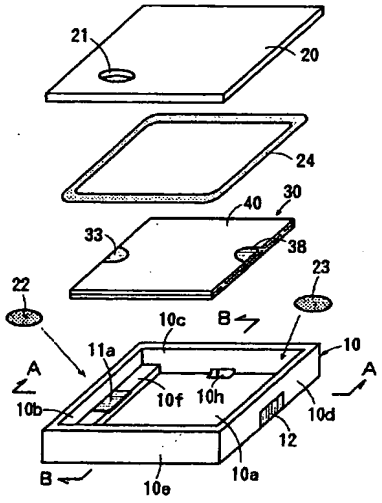
【符号の説明】

	１０	ケース
	２０	蓋板
	３０	圧電振動板（積層体）
	３１，３２	セラミック層
	３３，３４	外部電極
10	３３ａ，３４ａ	縁取り部
	３５	内部電極
	３６	ダミー電極
	３７，３９	端面電極
	３８	引出電極
	Ｇ	ギャップ

【図１】



【図２】



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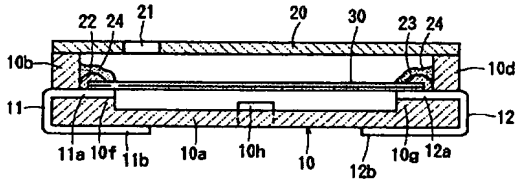

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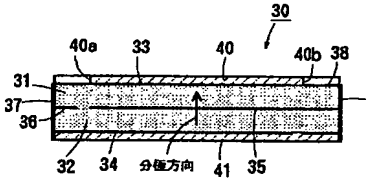

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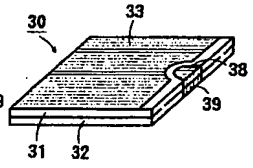

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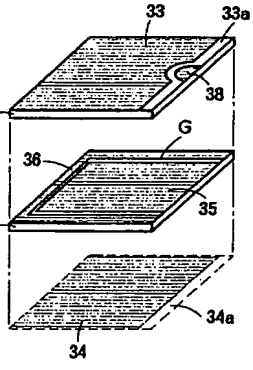

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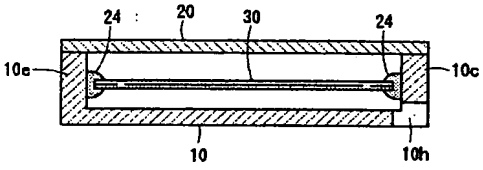

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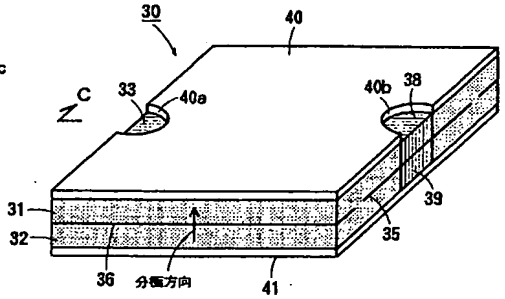

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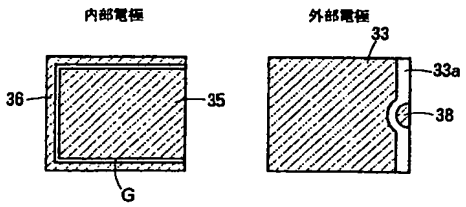
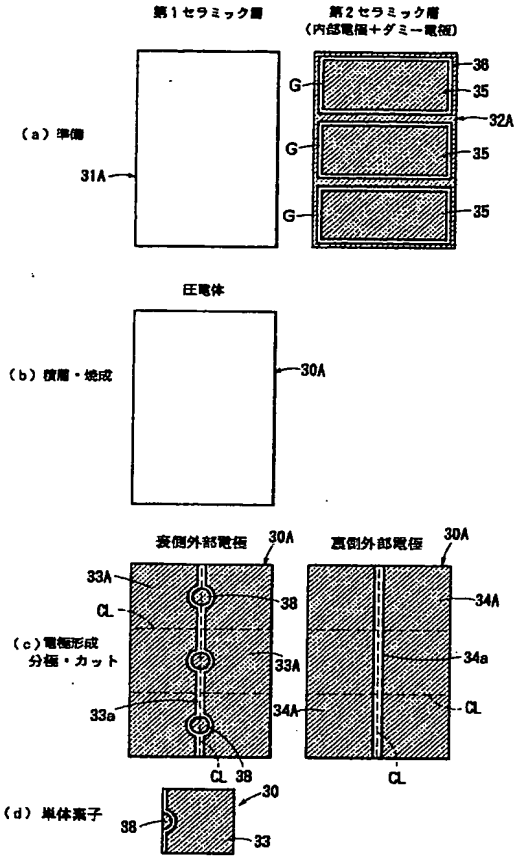
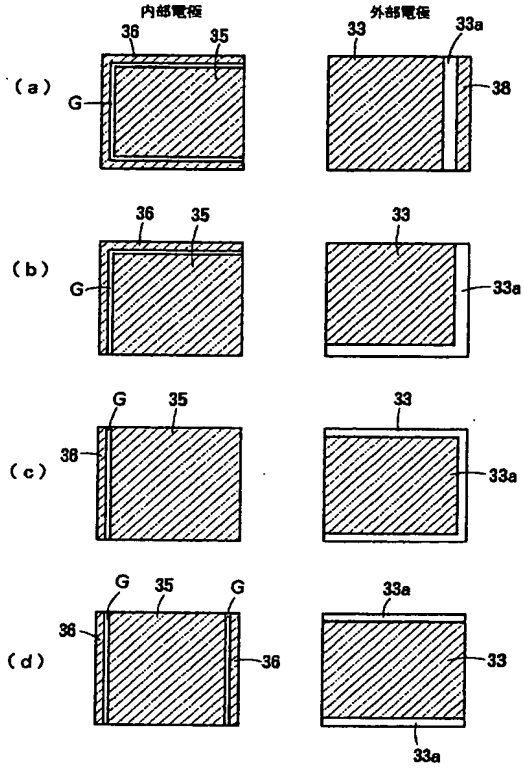


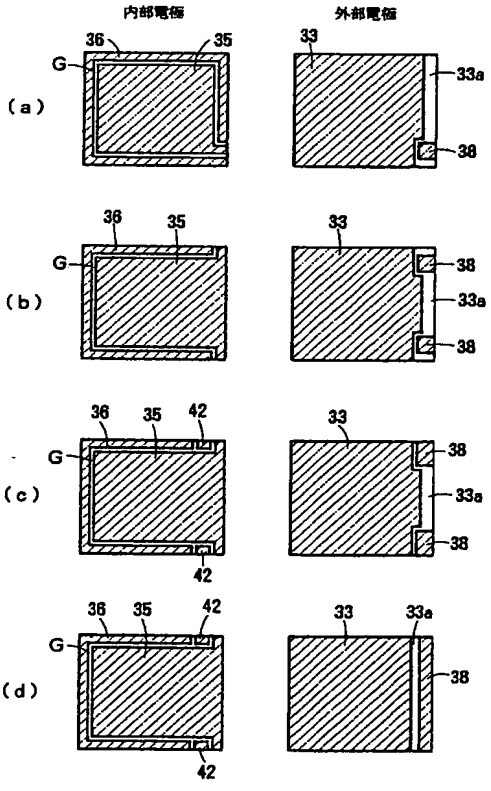
【図１０】


第１セラミック層
第２セラミック層
（内部電極＋ダミー電極）
（ａ）準備
31A
G
36
35
32A
（ｂ）積層・焼成
圧電体
30A
表側外部電極
裏側外部電極
33A
CL
38
（ｃ）電極形成
分極・カット
33a
34A
34a
（ｄ）単体素子
30
33

【図１１】


内部電極
外部電極
（ａ）
（ｂ）
（ｃ）
（ｄ）
G
35
36
33
33a
38

【図１２】


内部電極
外部電極
（ａ）
（ｂ）
（ｃ）
（ｄ）
G
35
36
42
33
33a
38

フロントページの続き

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(54) PIEZOELECTRIC ACOUSTIC CONVERTER AND ITS MANUFACTURING METHOD

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a piezoelectric acoustic converter in which failure rate can be improved by preventing short circuit of inner and outer electrodes due to migration and protecting a ceramic layer against cracking at the time of polarization.

SOLUTION: A plurality of piezoelectric ceramic layers 31 and 32 are laid in layer to form a multilayer body, and all ceramic layers 31 and 32 are polarized in the

same direction in the thickness direction. An AC signal is applied between outer electrodes 33 and 34 provided on the surface and rear of the multilayer body and an inner electrode 35 provided between the ceramic layers, thus causing bending vibration of the multilayer body. A dummy electrode 36 is provided between the piezoelectric ceramic layers 31 and 32 on the outside of the inner electrode 35 through a gap G, wherein a part of the inner electrode 35 is exposed to at least one end face of the piezoelectric ceramic layer and the dummy electrode 36 is exposed to the other end face of the piezoelectric ceramic layer. The outer electrodes 33 and 34 extend to an end face of the piezoelectric ceramic layer other than that where the inner electrode 35 is exposed.

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[Date of final disposal for application]	
[Patent number]	
[Date of registration]	
[Number of appeal against examiner's decision of rejection]	
[Date of requesting appeal against examiner's decision of rejection]	
[Date of extinction of right]	

CLAIMS

[Claim(s)]

[Claim 1] While carrying out the laminating of two or more piezo-electric ceramic layers, constituting a layered product and polarizing all ceramic layers in the same direction in the thickness direction By impressing an alternation signal between the external electrode prepared in the front flesh-side principal plane of a layered product, and the internal electrode prepared between each ceramic layer In the piezo-electric mold electroacoustic transducer which carries out the crookedness oscillation of the above-mentioned layered product between the above-mentioned piezo-electric ceramic layers The dummy electrode separated by the outside of the above-mentioned internal electrode through the gap is prepared. Some above-mentioned internal electrodes are exposed to at least one end face of a piezo-electric ceramic layer, and the above-mentioned dummy electrode is exposed to other end faces of a piezo-electric ceramic layer. The above-mentioned external electrode The piezo-electric mold electroacoustic transducer characterized by having extended to end faces other than the end face of the piezo-electric ceramic layer which the internal electrode has exposed.

[Claim 2] The gap width of face of the above-mentioned internal electrode and a dummy electrode is a piezo-electric mold electroacoustic transducer according to

claim 1 characterized by being 0.05-0.40mm.

[Claim 3] It is the piezo-electric mold electroacoustic transducer according to claim 1 or 2 characterized by preparing the burster-trimmer-stacker-feature section in the end face of the piezo-electric ceramic layer which the above-mentioned internal electrode is formed in a rectangle so that it may expose to one end face of a piezo-electric ceramic layer, the above-mentioned dummy electrode is formed in a KO typeface so that three sides of an internal electrode may be surrounded through a gap, and the above-mentioned internal electrode exposes, and the part of a corresponding external electrode.

[Claim 4] The piezo-electric mold electroacoustic transducer according to claim 3 characterized by forming the drawer electrode connected with the internal electrode through the end-face electrode prepared in the end face of a ceramic layer in the part in which the burster-trimmer-stacker-feature section of the above-mentioned external electrode was prepared.

[Claim 5] the above-mentioned drawer electrode -- two corners of a piezo-electric ceramic layer -- and the piezo-electric mold electroacoustic transducer according to claim 4 characterized by to be formed ranging over two different sides, to prepare the above-mentioned drawer electrode in the location with which it does not see and lap a dummy electrode and from thickness, and to form the island-like auxiliary electrode along with the end face of a piezo-electric ceramic layer between the both ends of the above-mentioned dummy electrode, and an internal electrode.

[Claim 6] The process for which two or more green sheets which consist of a piezo-electric ceramic are prepared, and the process which forms the electrode pattern used as an internal electrode and a dummy electrode in the front face of at least one green sheet, The process which carries out the laminating of the above-mentioned internal electrode and the dummy electrode for two or more green sheets in between, and obtains a layered product, The process which calcinates a layered product and obtains a piezo electric crystal, and the process which forms the electrode pattern used as the external electrode on a side front

in the front face of a piezo electric crystal, The process which forms the electrode pattern used as the external electrode on a background in the rear face of a piezo electric crystal, The process which impresses an electrical potential difference to the external inter-electrode one of a front flesh side, and performs polarization in the thickness direction of a piezo electric crystal uniformly, The process which cuts a piezo electric crystal into the dimension of one element, and the end-face electrode which makes the end face of the cut component flow through the external electrode of a front flesh side, In the condition of having the process which forms the end-face electrode for pulling out an internal electrode at either [at least] the front face of a component, or the rear face, and having cut the above-mentioned piezo electric crystal into the component Between piezo-electric ceramic layers, the dummy electrode separated by an internal electrode and its outside through the gap is prepared. Some internal electrodes are exposed to at least one end face of a piezo-electric ceramic layer, and the dummy electrode is exposed to other end faces of a piezo-electric ceramic layer. The external electrode of the above-mentioned table flesh side The manufacture approach of the piezo-electric mold electroacoustic transducer characterized by having extended to end faces other than the end face of the piezo-electric ceramic layer which the internal electrode has exposed.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to a piezo-electric mold electroacoustic transducer and its manufacture approaches, such as a piezo-electric earphone, a piezo-electric sounder, a piezoelectric loudspeaker, and a piezo-electric buzzer.

[0002]

[Description of the Prior Art] Conventionally, in electronic equipment, home electronics, a portable telephone, etc., the piezo-electric mold electroacoustic transducer is widely used as the piezo-electric buzzer which generates an alarm tone and a sound of operation, or a piezo-electric earphone. It is the thing of the structure which closed opening of a case with covering while this kind of piezo-electric mold electroacoustic transducer sticks a piezoelectric device on one side of a metal plate, constitutes a uni-morph mold diaphragm and supports the periphery section of a metal plate in a case. However, since in the case of a uni-morph mold diaphragm the ceramic plate which an outer diameter expands and contracts is pasted up on the metal plate which does not carry out a dimensional change and a crookedness oscillation is carried out by electrical-potential-difference impression, there is a fault of being small, the amount of displacement, i.e., sound pressure.

[0003] Then, the bimorph mold diaphragm of a laminated structure which consists of two or more piezo-electric ceramic layers is proposed (JP,2001-95094,A). This diaphragm forms an external electrode in the table rear face of this layered product, and prepares an internal electrode between each ceramic layer while it carries out the laminating of two-layer or the three-layer piezo-electric ceramic layer and obtains a layered product. Polarization of all the ceramic layers is carried out in the thickness direction in the same direction, and

they carry out the crookedness oscillation of the layered product by impressing an alternation signal between an external electrode and an internal electrode. In the diaphragm of such a laminated structure, compared with a uni-morph mold diaphragm, the amount of displacement is large, and there is an advantage to which sound pressure increases.

[0004]

[Problem(s) to be Solved by the Invention] Since each ceramic layer is thin meat when manufacturing the diaphragm of the above laminated structures, there is a problem of being easy to short-circuit the internal electrode and external electrode which are exposed to the end face of a layered product by migration. While making at least one side of the ceramic layer 1 expose the external electrodes 2 and 3 of a front flesh side as a cure against migration as shown in drawing 1 The burster-trimmer-stacker-feature sections 2a and 3a which excised the external electrodes 2 and 3 are formed in other sides, burster-trimmer-stacker-feature section 4a of an internal electrode 4 is formed in the side which the external electrodes 2 and 3 exposed, and how to make it into the electrode configuration which made the remaining sides expose an internal electrode 4 can be considered. In addition, in drawing 1 , the external electrode 3 on a background is drawn as projection drawing. By considering as such an electrode configuration, in the end face of the ceramic layer 1, the external electrodes 2 and 3 and an internal electrode 4 do not approach in the thickness direction, but migration can be canceled. In addition, with this, although the burster-trimmer-stacker-feature sections 2a and 3a were formed in three sides of the external electrodes 2 and 3 and burster-trimmer-stacker-feature section 4a was formed in one side of an internal electrode 4 in drawing 1 , even if it forms the burster-trimmer-stacker-feature section in reverse at three sides of an internal electrode 4 and forms the burster-trimmer-stacker-feature section in one side of the external electrodes 2 and 3, it has the same effectiveness.

[0005] However, when direct current voltage is impressed and polarization is performed between the external electrode 2 of a front flesh side, and 3 to a

layered product with the above electrode configurations, a difference arises on the elongation of the ceramic layer 1 between an internal electrode 4 and burster-trimmer-stacker-feature section 4a, a crack occurs in the ceramic layer 1 of the boundary of an internal electrode 4 and burster-trimmer-stacker-feature section 4a, and there is a problem of reducing the rate of an excellent article. That is, it is because the elongation of the ceramic layer 1 becomes large and a crack occurs in the ceramic layer 1 according to the difference of the elongation in the side which the internal electrode 4 has exposed to the end face in the side in which burster-trimmer-stacker-feature section 4a was prepared to the elongation of the ceramic layer 1 being controlled with the electrode 4.

[0006] Then, the object of this invention prevents the crack of the ceramic layer at the time of polarization, and is to offer the piezo-electric mold electroacoustic transducer which can improve the rate of an excellent article while it prevents the short circuit of the internal electrode and external electrode by migration.

[0007]

[Means for Solving the Problem] In order to attain the above-mentioned object, invention concerning claim 1 While carrying out the laminating of two or more piezo-electric ceramic layers, constituting a layered product and polarizing all ceramic layers in the same direction in the thickness direction By impressing an alternation signal between the external electrode prepared in the front flesh-side principal plane of a layered product, and the internal electrode prepared between each ceramic layer In the piezo-electric mold electroacoustic transducer which carries out the crookedness oscillation of the above-mentioned layered product between the above-mentioned piezo-electric ceramic layers The dummy electrode separated by the outside of the above-mentioned internal electrode through the gap is prepared. Some above-mentioned internal electrodes are exposed to at least one end face of a piezo-electric ceramic layer, and the above-mentioned dummy electrode is exposed to other end faces of a piezo-electric ceramic layer. The above-mentioned external electrode The piezo-electric mold electroacoustic transducer characterized by having extended to end

faces other than the end face of the piezo-electric ceramic layer which the internal electrode has exposed is offered.

[0008] Moreover, the process for which two or more green sheets with which invention concerning claim 6 consists of a piezo-electric ceramic are prepared, The process which forms the electrode pattern used as an internal electrode and a dummy electrode in the front face of at least one green sheet, The process which carries out the laminating of the above-mentioned internal electrode and the dummy electrode for two or more green sheets in between, and obtains a layered product, The process which calcinates a layered product and obtains a piezo electric crystal, and the process which forms the electrode pattern used as the external electrode on a side front in the front face of a piezo electric crystal, The process which forms the electrode pattern used as the external electrode on a background in the rear face of a piezo electric crystal, The process which impresses an electrical potential difference to the external inter-electrode one of a front flesh side, and performs polarization in the thickness direction of a piezo electric crystal uniformly, The process which cuts a piezo electric crystal into the dimension of one element, and the end-face electrode which makes the end face of the cut component flow through the external electrode of a front flesh side, In the condition of having the process which forms the end-face electrode for pulling out an internal electrode at either [at least] the front face of a component, or the rear face, and having cut the above-mentioned piezo electric crystal into the component Between piezo-electric ceramic layers, the dummy electrode separated by an internal electrode and its outside through the gap is prepared. Some internal electrodes are exposed to at least one end face of a piezo-electric ceramic layer, and the dummy electrode is exposed to other end faces of a piezo-electric ceramic layer. The external electrode of the above-mentioned table flesh side It is the manufacture approach of the piezo-electric mold electroacoustic transducer characterized by having extended to end faces other than the end face of the piezo-electric ceramic layer which the internal electrode has exposed.

[0009] Although an internal electrode and a dummy electrode are prepared between ceramic layers, since two electrodes are separated through the gap, it has not flowed electrically. Some internal electrodes are exposed to at least one end face of a ceramic layer, and the dummy electrode is exposed to other end faces of a ceramic layer. And the external electrode is prolonged to end faces other than the end face of the ceramic layer which the internal electrode has exposed. If it puts in another way, the external electrode is not prolonged to the end face which the internal electrode exposed. Therefore, in the end face of a ceramic layer, an internal electrode and an external electrode do not approach in the thickness direction, but can prevent the short circuit by migration. Moreover, a dummy electrode and an external electrode approach in the thickness direction, and although it may connect too hastily, since the dummy electrode and the internal electrode are insulated electrically, they do not have a fear of an external electrode and an internal electrode short-circuiting. Moreover, since the dummy electrode is prepared in the part in which an internal electrode does not exist even if the difference of elongation arises in a ceramic layer in the part to which an internal electrode exists at the time of polarization, and the part not existing, the difference of the elongation of a ceramic layer becomes small and can control the crack of a ceramic layer.

[0010] It does not need to continue and expose to the overall length of one side of a ceramic layer, you may expose to a part of one side, and the internal electrode may be continued and exposed to two sides or three sides. What similarly does not need to expose exposure of an external electrode covering the overall length of the side of a ceramic layer, either, and was exposed selectively may be used. A ceramic layer may be not only two-layer but three layers. Since an internal electrode is prepared in both sides of a central ceramic layer in the case of three layers, potential is equal and does not contribute to a crookedness oscillation.

[0011] Like claim 2, it is desirable to set gap width of face of an internal electrode and a dummy electrode to 0.05-0.40mm. If gap width of face is made large, the

difference of the elongation of the ceramic layer at the time of polarization will become large, and will cause a crack. When gap width of face is narrowed too much, it becomes impossible on the other hand, to maintain the distance for insulation of an internal electrode and a dummy electrode. Then, it is [width of face / gap] compatible in 0.05-0.40mm then prevention of a crack, and reservation of the distance for insulation.

[0012] Like claim 3, it may form in a rectangle so that an internal electrode may be exposed to one end face of a piezo-electric ceramic layer, and the burster-trimmer-stacker-feature section may be prepared in the end face of the piezo-electric ceramic layer to which three sides of an internal electrode are formed in a KO typeface so that it may surround through a gap, and an internal electrode exposes a dummy electrode, and the part of a corresponding external electrode. In this case, the electrode configuration of an internal electrode and an external electrode is simplified, and manufacture becomes easy. Moreover, since an internal electrode is not exposed to one side, migration cannot happen easily and the diaphragm of the stable property is obtained.

[0013] Like claim 4, the drawer electrode connected with the internal electrode through the end-face electrode may be formed in the part in which the burster-trimmer-stacker-feature section of the external electrode in claim 3 was prepared. That is, since it is prepared between ceramic layers, if an internal electrode remains as it is, it is not connectable [since the external electrode of a diaphragm is exposed outside the electrical installation with the exterior is easy, but] with the exterior. Then, it connects through the end-face electrode in which the drawer electrode was prepared in the part to which the internal electrode was prepared in the burster-trimmer-stacker-feature section of an external electrode in order [of a diaphragm] to pull out on a front face at least, and this drawer electrode and internal electrode were prepared by the end face of a ceramic layer. An internal electrode is easily connectable with the exterior with this.

[0014] claim 5 -- like -- a drawer electrode -- two corners of a piezo-electric ceramic layer -- and it forms ranging over two different sides, and a drawer

electrode may be prepared in the location with which it does not see and lap a dummy electrode and from thickness, and an island-like auxiliary electrode may be formed along with the end face of a piezo-electric ceramic layer between the both ends of a dummy electrode, and an internal electrode. Thus, when taking and carrying out many layered products from a big mother substrate while being able to prevent the crack at the time of polarization if constituted, it is easy to respond to dispersion in a cut location and an electrode formation location. Moreover, since width of face of a drawer electrode can be comparatively made large, it is effective.

[0015] By the manufacture approach of claim 6, the diaphragm in claim 1 can be manufactured efficiently. The diaphragm which consists of a multilayer piezoelectric transducer in a manufacture process in the approach of etching this and using as an external electrode after forming the electrode for polarization is a crack and a cone. especially -- thickness -- 50 micrometers or less -- thin -- in a **** diaphragm, the crack by handling etc. and a chip percent defective get worse substantially in etching processing. On the other hand, since the electrode for polarization is used as an external electrode as it is in claim 6, etching becomes unnecessary, and a load is not applied to a diaphragm, but a crack and a chip percent defective can be improved.

[0016]

[Embodiment of the Invention] Drawing 2 - drawing 9 show the piezo-electric mold electroacoustic transducer of the surface mount mold which is the 1st operation gestalt of this invention. This electroacoustic transducer consists of the profile, a case 10, a cover plate 20, and a diaphragm 30 of a laminated structure.

[0017] The case 10 is formed in the core box of four square shapes which have bottom wall section 10a and the four side-attachment-wall sections 10b-10e with insulating ingredients, such as ceramics or resin. When it constitutes a case 10 from resin, heat-resistant resin, such as LCP (liquid crystal polymer), SPS (syndiotactic polystyrene), PPS (polyphenylene sulfide), and epoxy, is desirable. Inside the two side-attachment-wall sections 10b and 10d which counter, the

level difference-like supporters 10f and 10g were formed, and the internal connection sections 11a and 12a of the terminals 11 and 12 of a couple are exposed on it. Insert molding of the terminals 11 and 12 is carried out to a case 10, and the external connections 11b and 12b which projected in the exterior of a case 10 are bent to the base side of a case 10 along the outside surface which are the side-attachment-wall sections 10b and 10d. 10h of 1st sound emission hole is formed in the boundary of other one side-attachment-wall section 10c and bottom wall section 10a of a case 10. The cover plate 20 which consists of the same ingredient as a case 10 pastes top-face opening of a case 10 with adhesives (not shown). The 2nd sound emission hole 21 is formed in the cover plate 20.

[0018] As shown in drawing 5 - drawing 9 , a diaphragm 30 carries out the laminating of the two-layer electrostrictive ceramics layers 31 and 32, and covers the table rear face in the resin layers 40 and 41. These resin layers 40 and 41 are the protective coats for preventing the crack by the drop impact of the ceramic layers 31 and 32 etc. Here, the 10mmx10mmx20micrometer PZT system ceramics was used as ceramic layers 31 and 32, and the polyamidoimide system resin whose thickness is 5-10 micrometers as resin layers 40 and 41 was used.

[0019] The external electrodes 33 and 34 are formed in the front flesh-side principal plane of the ceramic layers 31 and 32 by which the laminating was carried out, and the internal electrode 35 and the dummy electrode 36 are formed among the ceramic layers 31 and 32. As a thick wire arrow head shows to drawing 5 and drawing 6 , in the thickness direction, polarization of the two ceramic layers 31 and 32 is carried out in the same direction. The burster-trimmer-stacker-feature sections (or null section) 33a and 34a were formed in one side of the external electrode 33 on a side front, and the external electrode 34 on a background, and other sides are extended to the edge of the ceramic layers 31 and 32. And the external electrodes 33 and 34 extended to the edge are connected to the end-face electrode 37 (refer to drawing 6) formed in one

end face of a diaphragm 30. Therefore, the external electrodes 33 and 34 of a front flesh side are connected mutually. The external electrode 33 and the drawer electrode 38 not flowing are formed in the front face of the ceramic layer 31 in which burster-trimmer-stacker-feature section 33a of the external electrode 33 on a side front was prepared. An internal electrode 35 is formed in a rectangle so that it may expose only to the end face of the ceramic layers 31 and 32 in which the burster-trimmer-stacker-feature sections 33a and 34a of the external electrodes 33 and 34 were formed, and the dummy electrode 36 is formed in the KO typeface so that three sides of an internal electrode 35 may be surrounded through a gap G. The width of face of this gap G had 0.05-0.40 desirablemm, and it set it as 0.15mm here. The dummy electrode 36 is exposed to the end face of three sides of the ceramic layers 31 and 32. The end-face electrode 39 which connects an internal electrode 35 and the drawer electrode 38 is formed in the end face in which the end-face electrode 37 was formed, and the end face of the diaphragm 30 which counters. In addition, by forming the end-face electrode 37, it connects also with the dummy electrode 36 at the same time the external electrodes 33 and 34 are connected mutually. However, since the dummy electrode 36 is electrically insulated with the internal electrode 35, it is convenient to electrical characteristics.

[0020] Notch 40a which the external electrode 33 exposes to two sides which a diaphragm 30 counters, and notch 40b which the drawer electrode 38 exposes are formed in the resin layer 40 on a side front. In addition, although Notches 40a and 40b were formed only in the front face in this example, you may prepare in front flesh-side both sides. What is necessary is to expose the external electrode 34 to notch 40a on the back, and just to expose the drawer electrode 38 to notch 40b on the back, in forming Notches 40a and 40b in front flesh-side both sides.

[0021] The above-mentioned diaphragm 30 is contained by the case 10, and two sides which counter are Supporters 10f and 10g, and it is laid upwards. And the external electrode 33 and internal connection section 11a of a terminal 11 which are exposed from notch 40a of the resin layer 40 are connected by

electroconductive glue 22, and the drawer electrode 38 and internal connection section 12a of a terminal 12 which are similarly exposed from notch 40b are connected by electroconductive glue 23. After stiffening electroconductive glue 22 and 23, the air leak between the side front of a diaphragm 30 and a background is prevented by applying the elastic encapsulants 24, such as silicone system adhesives, to the clearance between the perimeter of a diaphragm 30, and a case 10 annularly, and making it harden them. In addition, not only the approach of applying the elastic encapsulant 24 and stiffening, after applying and stiffening electroconductive glue 22 and 23 but after applying and stiffening the elastic encapsulant 24 previously, electroconductive glue 22 and 23 may be applied and stiffened. Moreover, electroconductive glue 22 and 23 is in the condition beforehand applied to the both ends of a diaphragm 30, and may be held in a case 10.

[0022] In the electroacoustic transducer of this operation gestalt, by impressing a predetermined alternation electrical potential difference between a terminal 11 and 12, an alternation electrical potential difference is impressed between the external electrodes 33 and 34 and an internal electrode 35, and the crookedness oscillation of the diaphragm 30 can be carried out. Since the electrostrictive ceramics layer the direction of polarization and whose direction of electric field are the same directions is shrunken in the direction of a flat surface and the electrostrictive ceramics layer the direction of polarization and whose direction of electric field are hard flow is extended in the direction of a flat surface, it is crooked in the thickness direction as a whole. A diaphragm 30 is the laminating structure of the electrostrictive ceramics which does not have a metal plate, and since two oscillating fields arranged in order in the thickness direction vibrate to hard flow mutually, compared with a uni-morph mold diaphragm, the big amount of displacement, i.e., big sound pressure, can be obtained. The sound generated with the diaphragm 30 is emitted to the exterior from the 2nd sound emission hole 21 prepared in the cover plate 20. Moreover, in the end face of the two-layer piezo-electric ceramic layers 31 and 32, since the external electrodes 33 and 34

and an internal electrode 35 do not approach, the short circuit of the external electrodes 33 and 34 and internal electrode 35 by migration can be prevented.
[0023] Drawing 10 shows the production process of a diaphragm 30. As shown in (a), 1st ceramic green sheet 31A which does not form the electrode, and 2nd ceramic green sheet 32A in which the internal electrode 35 and the dummy electrode 36 were formed on the front face are prepared. As a ceramic green sheet, the PZT system ceramics was used, for example. Moreover, the conductive paste containing silver, palladium, an organic binder, etc. was applied by print processes as an internal electrode 35 and a dummy electrode 36. Next, as shown in (b), the laminating of the green sheets 31A and 32A is carried out, and it calcinates at about 1100 degrees C, and with a thickness of about 40 micrometers piezo electric crystal 30A is obtained. Next, as shown in (c), while forming external electrode 33A on a side front in the front face of piezo electric crystal 30A of a mother substrate condition, external electrode 34A on a background is formed in the rear face of piezo electric crystal 30A. For example, the thin film forming methods, such as sputtering using the metal mask as the formation approach, were used. At this time, the island-like electrode used as null section 33a used as the burster-trimmer-stacker-feature section and the drawer electrode 38 is formed in external electrode 33A on a side front. Moreover, null section 34a used as the burster-trimmer-stacker-feature section is formed in external electrode 34A on a background. After formation of the external electrodes 33A and 34A, between external electrode 33A of the front flesh side of piezo electric crystal 30A, and 34A, an electrical potential difference is impressed and polarization is performed. Polarization conditions presupposed that it is fixed at electric-field:3.0kV/mm and holding-time x retention temperature =30secx50 degree C. Since the null section hardly exists in the electrodes 35 and 36 prepared between ceramic layers at this time, there is almost no difference of the elongation of a ceramic layer, and the crack of a ceramic layer can be prevented. Resin coating is performed to the table rear face of piezo electric crystal 30A after polarization, it cuts with the broken line CL of (c), and a component as

shown in (d) is obtained. At this time, it cuts so that Cutline CL may pass along the core of the burster-trimmer-stacker-feature sections 33a and 34a. While forming the resin layers 40 and 41 in the table rear face of the cut component, a diaphragm 30 is obtained by forming the end-face electrodes 37 and 39.

[0024] After forming an electrode in the whole surface first on the need of preparing burster-trimmer-stacker-feature section 2a in the perimeter of the external electrode 2 in the case of an external electrode configuration as shown in drawing 1 , resist ink is applied to the part equivalent to the burster-trimmer-stacker-feature section, and the process of etching and forming burster-trimmer-stacker-feature section 2a is needed. on the other hand -- since an electrode configuration can be simplified when the external electrodes 33A and 34A are extended to three sides as mentioned above, complicated processing of etching etc. is unnecessary -- becoming -- pattern NINGU of a low load -- it becomes possible to choose law. therefore, the crack by simplification and handling of a process and a poor chip -- improvable -- thin -- even if it is **** piezo electric crystal 30A, the rate of an excellent article can improve and fertilize.

[0025] Drawing 11 shows other examples of the external electrode in a diaphragm, and an internal electrode. At (a), although the configuration of an internal electrode 35 and the dummy electrode 36 is equivalent to the 1st example, it differs from the 1st example in that the band-like drawer electrode 38 was formed in one side of the external electrode 33 through null section 33b. This drawer electrode 38 is connected with an internal electrode 35 through an end-face electrode. In (b), two side of ****** of an internal electrode 35 are exposed to the end face of a ceramic layer, and the dummy electrode 36 is formed in the two remaining sides through the gap G. Similarly burster-trimmer-stacker-feature section 33a was formed in two sides which two sides, especially internal electrode 35 of the external electrode 33 expose, and a corresponding part, and other two sides are extended to the periphery of a ceramic layer. Three sides of an internal electrode 35 have exposed (c) to the end face of a ceramic layer, and the dummy electrode 36 is formed in the one remaining sides through

the gap G. Moreover, burster-trimmer-stacker-feature section 33a was formed in three sides to expose, three sides 35, i.e., the internal electrode, of the external electrode 33, and a corresponding part, and the one remaining sides are extended to the periphery section of a ceramic layer. Two sides which an internal electrode 35 counters have exposed (d) to the end face of a ceramic layer, and the dummy electrode 36 is formed in the two remaining sides through the gap G. Burster-trimmer-stacker-feature section 33a was formed in two sides which two sides, especially internal electrode 35 of the external electrode 33 expose, and a corresponding part, and other two sides are extended to the periphery of a ceramic layer. (a) Any electrode configuration of - (d) can prevent the crack at the time of polarization, while being able to prevent migration. In addition, what is necessary is just to make the external electrode 34 on a background into the same configuration as the external electrode 33 on a side front.

[0026] Drawing 12 shows the example of further others of the external electrode in a diaphragm, and an internal electrode. In (a), the internal electrode 35 is exposed to a part of ceramic layer in one side, and the dummy electrode 36 encloses other parts through the gap G. On the other hand, burster-trimmer-stacker-feature section 33a is formed in the side which the internal electrode 35 of the external electrode 33 exposed, and the island-like drawer electrode 38 is formed in the part which the internal electrode 35 exposed in this burster-trimmer-stacker-feature section 33a, and the corresponding part. This drawer electrode 38 is also connected with an internal electrode 35 through an end-face electrode. In (b), it has exposed to a part of two sides where an internal electrode 35 adjoins one side and its side of a ceramic layer, and the dummy electrode 36 encloses other parts through the gap G. On the other hand, burster-trimmer-stacker-feature section 33a is formed in the side which the internal electrode 35 of the external electrode 33 exposed, and the island-like drawer electrode 38 is formed in the part which the internal electrode 35 exposed near the both ends of burster-trimmer-stacker-feature section 33a further, and the corresponding part. This drawer electrode 38 is connected with an internal electrode 35 through an

end-face electrode. Since the external electrode 33 is in the condition that the internal electrode 35 was also mutually connected in the phase of a mother substrate, of course in the case of this electrode pattern, there is an advantage to which formation of an internal electrode 35 becomes easy. (c) corrected the electrode configuration of (b), and has exposed it to a part of two sides where an internal electrode 35 adjoins one side and its side of a ceramic layer, and the dummy electrode 36 encloses other parts through the gap G. Between the dummy electrode 36 and the internal electrode 35, two island-like auxiliary electrodes 42 are formed along with the end face of a ceramic layer. Burster-trimmer-stacker-feature section 33a is formed in the side which the internal electrode 35 of the external electrode 33 exposed, and the internal electrode 35 and the auxiliary electrode 42, and the corresponding island-like drawer electrode 38 are formed in the both ends of burster-trimmer-stacker-feature section 33a. In this example, by arranging the drawer electrode 38 to the corner of a ceramic layer, formation of the drawer electrode 38 becomes easy and mass production nature improves. If an internal electrode 35 and the dummy electrode 36 are made into a configuration as shown in (b), the dummy electrode 36 and the drawer electrode 38 will lap in the thickness direction, and a possibility of connecting too hastily by migration will arise. Then, the short circuit of the dummy electrode 36 and the drawer electrode 38 is prevented by forming an auxiliary electrode 42 between the dummy electrode 36 and an internal electrode 35. Moreover, when taking and carrying out many diaphragms from a mother substrate in this example, since it is easy to respond to dispersion in a cut location and an electrode formation location and the large width of face of the drawer electrode 38 can be taken, it is effective. (d) makes an internal electrode 35, the dummy electrode 36, and an auxiliary electrode 42 be the same as that of (c) of drawing 12 , and makes the external electrode 33 be the same as that of (a) of drawing 11 . That is, the band-like drawer electrode 38 is formed in one side of the external electrode 33 through null section 33b. It can prevent that the drawer electrode 38 and the dummy electrode 36 short-circuit with an auxiliary

electrode 42 also in this case.

[0027] This invention is not limited to the above-mentioned operation gestalt, and can be changed in the range which does not deviate from the meaning of this invention. For example, although a diaphragm 30 carries out the laminating of the two-layer electrostrictive ceramics layer, what carried out the laminating of the three or more-layer electrostrictive ceramics layer may be used. Moreover, everything but a square of a diaphragm 30 may be circular.

[0028] The case of this invention is not restricted to what consisted of a case with a terminal as shown in drawing 2 - drawing 4 , and a cover plate adhered to the top face. For example, as shown in drawing 7 of above-mentioned JP,2001-95094,A, and drawing 8 , a case may consist of a cap with the supporter which can carry out support immobilization of the diaphragm, and a substrate with the electrode for external connection. You may be the electrode of the thin film from the supporter top face of a case to [as a terminal fixed to a case, does not restrict to an insertion terminal like the above-mentioned operation gestalt and] outside for example, or a thick film.

[0029]

[Effect of the Invention] The dummy electrode which was separated by an internal electrode and its outside through the gap between ceramic layers by the above explanation according to invention concerning claim 1 so that clearly is prepared. While exposing some internal electrodes to at least one end face of a ceramic layer Since it extended to end faces other than the end face of the piezo-electric ceramic layer to which the dummy electrode was exposed to other end faces of a ceramic layer, and the internal electrode has exposed the external electrode of a front flesh side In the end face of a ceramic layer, an internal electrode and an external electrode do not approach in the thickness direction, but the short circuit by migration can be prevented. Moreover, since the dummy electrode is prepared in the part in which an internal electrode does not exist even if the difference of elongation arises in a ceramic layer in the part to which an internal electrode exists at the time of polarization, and the part not existing,

the difference of the elongation of a ceramic layer becomes small and it has the operation effectiveness that the crack of a ceramic layer can be controlled.

[0030] According to invention concerning claim 6, since the electrode for polarization is used as an external electrode as it is, etching becomes unnecessary, and a load is not applied to a diaphragm, but a crack and a chip percent defective can be improved. Therefore, the diaphragm which consists of a multilayer piezoelectric transducer can be manufactured efficiently.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the decomposition perspective view of the piezo-electric diaphragm which will be the requisite for this invention.

[Drawing 2] It is the decomposition perspective view of the 1st operation gestalt of the piezo-electric mold electroacoustic transducer concerning this invention.

[Drawing 3] It is the A-A line sectional view of drawing 2 .

[Drawing 4] It is the B-B line sectional view of drawing 2 .

[Drawing 5] It is the perspective view of the piezo-electric diaphragm used for the piezo-electric mold electroacoustic transducer of drawing 2 .

[Drawing 6] It is the C-C line sectional view of drawing 5 .

[Drawing 7] It is a perspective view in the condition of having removed the resin layer of the piezo-electric diaphragm shown in drawing 5 .

[Drawing 8] It is the decomposition perspective view of the piezo-electric diaphragm shown in drawing 7 .

[Drawing 9] It is the internal electrode and external electrode drawing of a piezo-electric diaphragm which are shown in drawing 7 .

[Drawing 10] It is process drawing showing the manufacture approach of the piezo-electric diaphragm shown in drawing 7 .

[Drawing 11] They are other pattern drawings of the internal electrode of a piezo-electric diaphragm, and an external electrode.

[Drawing 12] It is pattern drawing of further others of the internal electrode of a piezo-electric diaphragm, and an external electrode.

[Description of Notations]

10 Case

20 Cover Plate

30 Piezo-electric Diaphragm (Layered Product)

31 32 Ceramic layer

33 34 External electrode

33a, 34a Burster-trimmer-stacker-feature section

35 Internal Electrode

36 Dummy Electrode

37 39 End-face electrode

38 Drawer Electrode

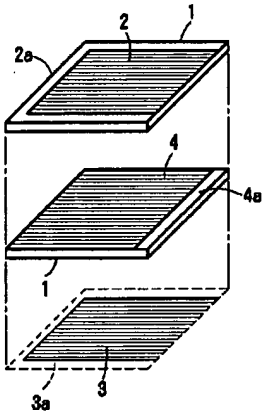
G Gap

[Translation done.]

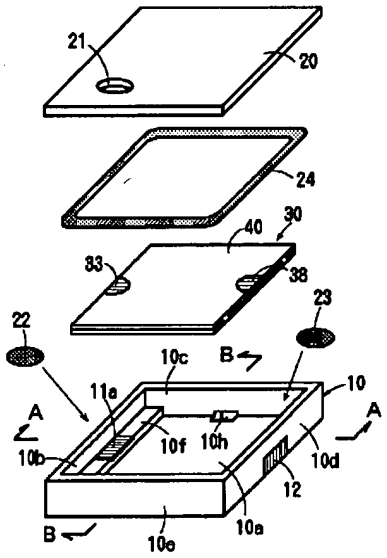
* NOTICES *

DRAWINGS

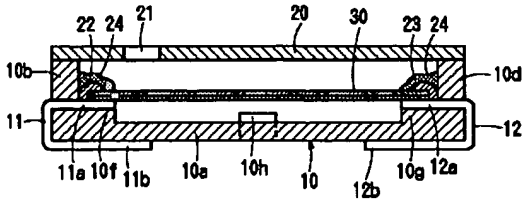
[Drawing 1]



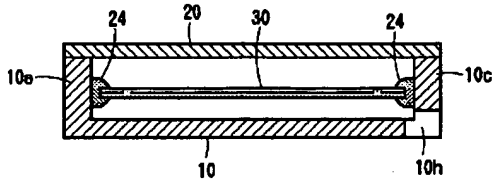
[Drawing 2]



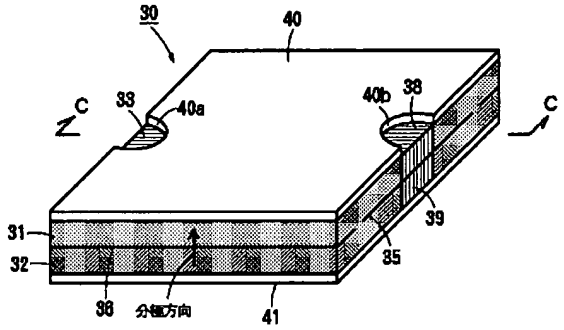
[Drawing 3]



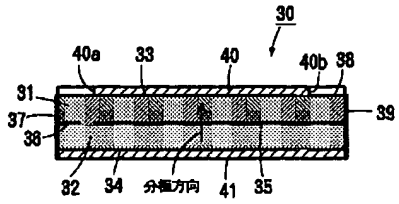
[Drawing 4]



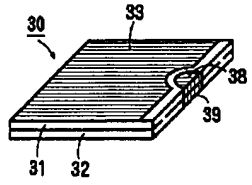
[Drawing 5]



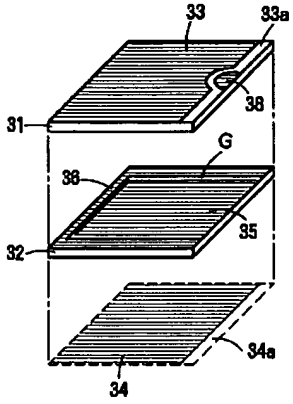
[Drawing 6]



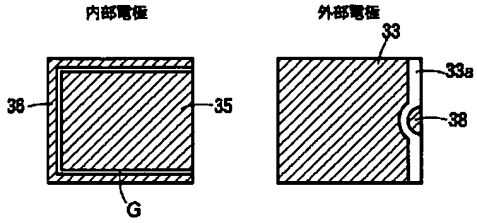
[Drawing 7]



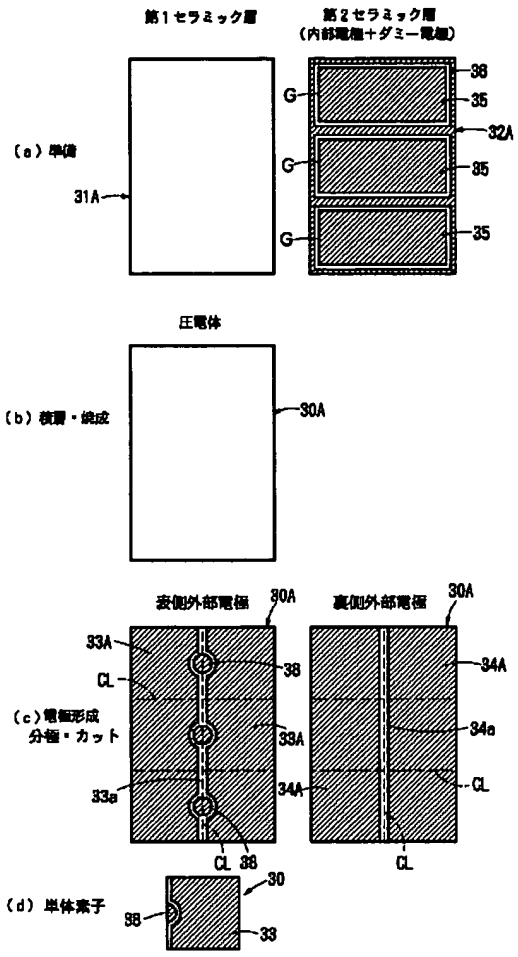
[Drawing 8]



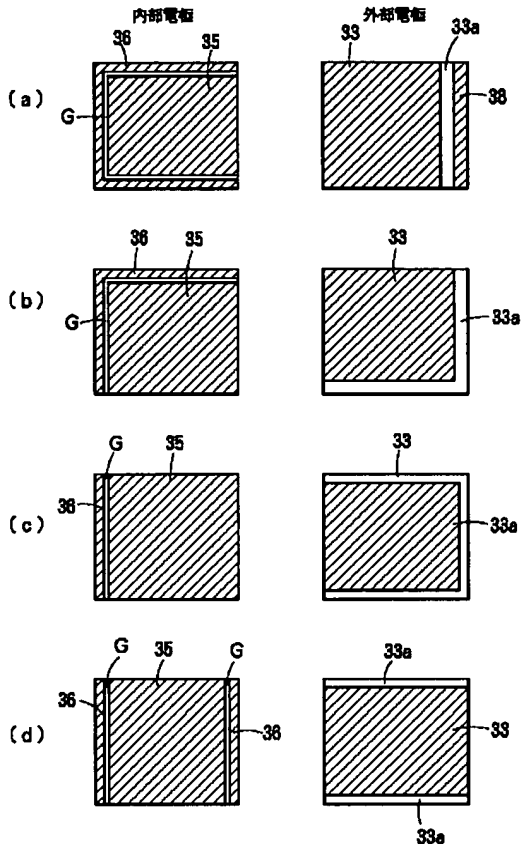
[Drawing 9]



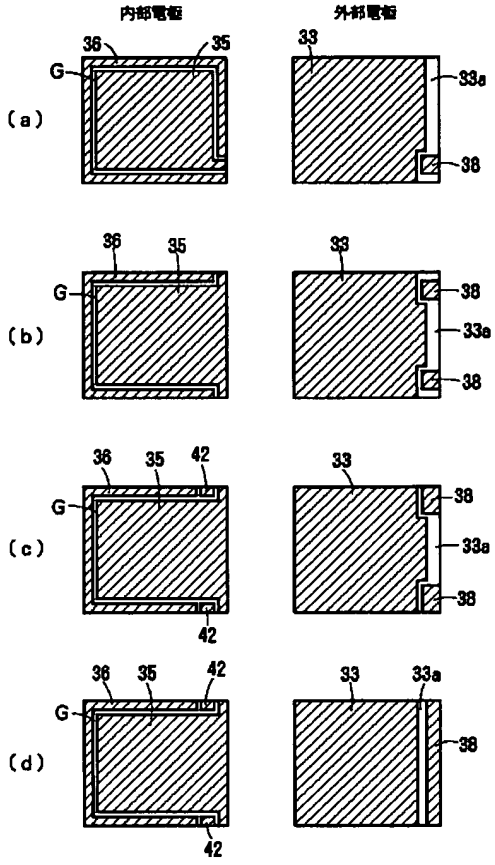
[Drawing 10]


第1セラミック層
第2セラミック層
(内部電極+ダミー電極)
(a) 準備
31A
G
G
G
36
35
32A
35
35
圧電体
(b) 積層・焼成
30A
表側外部電極
30A
裏側外部電極
30A
33A
CL
(c) 電極形成
分極・カット
33a
38
33A
34A
34a
CL
CL
CL
38
(d) 単体素子
30
38
33

[Drawing 11]



[Drawing 12]



[Translation done.]